Research on quality of road runoff in Tokyo metropolitan area

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Abstract

Road runoff flows into public water bodies, and influences the water quality. The purpose of this research is to clarify the situation of chemical substances contained in road runoff. The sources of the chemical substances are road structure and vehicles in addition to substances contained in the rainfall and dust fall.

In this research, we investigated road runoff from fiscal year 2004 to 2008. And, we have understood the situation, and have presumed of emission source of those chemical substances and have examined decreasing measures.

Through in this research, we pay attention to zinc and lead. These substances are comparatively high concentration compared with the standard. Especially, the zinc is high concentration in the slope of heavy traffic section. We have presumed that the zinc emit mainly from dust originated from tire. We have been convinced that it is effective for decreasing the zinc to vacuum the dust efficiently. Then, we have verified the effect of the road cleaning as measures to decrease the zinc.

1. Survey of chemical substances included in road runoff

Road runoff contains chemical substances coming from road origin, deposit dust, and floating dust (See figure1,2).

road origin＝road runoff－roof runoff

deposit dust）＝roof runoff）－rain water

The ratio of each estimated concentrations of road origin, deposit dust, and floating dust are shown in Table 1.

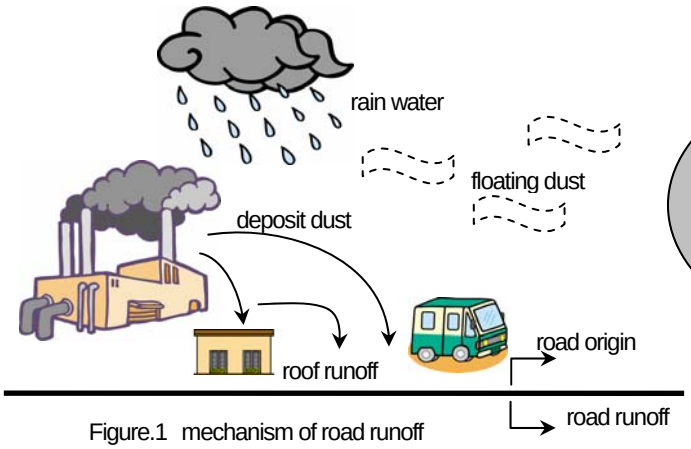

Figure.1 mechanism of road runoff

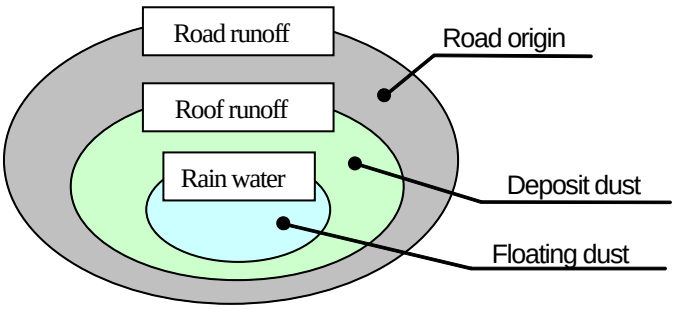

Figure.2 Concept of the sample

Table1 shows that SS and Zn are over Japanese Environmental Standards of open water. SS (Suspended Solid)

Environmental Standards of open water is applicable for sunny conditions. We regard that SS does not mater. We think that we have to take care of Zn.

We have picked up No.3 and No.17 as detailed investigation points.

Table.1 Survey of SS Pb. Zn in road runoff

No.	SS			Pb			Zn		
	road	Roof	Rain	road	Roof	Rain	road	Roof	Rain
No. 1	44.4	17.7	7.3	0.012	0.024	0.015	0.127	0.079	0.196
No. 2	205.9	38.1	6.0	0.039	0.015	0.005	0.700	0.096	0.057
No. 3	83.7	21.5	8.1	0.016	0.009	0.007	2.951	0.093	0.032
No. 4	42.0	14.9	16.3	0.009	0.003	0.010	0.375	0.041	0.497
No. 5	39.5	28.0	6.5	0.072	0.006	0.060	0.359	0.173	0.074
No. 6	64.1	7.9	5.5	0.013	0.010	0.012	0.486	0.506	0.053
No. 7	128.7	5.9	16.7	0.028	0.002	0.005	0.383	0.038	0.059
No. 8	34.6	19.2	11.4	0.010	0.008	0.005	0.127	0.126	0.069
No. 9	143.3	22.8	7.0	0.014	0.012	0.005	0.382	0.191	0.044
No. 10	79.2	35.2	4.0	0.013	0.037	0.003	0.702	0.824	0.043
No. 11	123.5	26.2	4.4	0.018	0.014	0.004	0.428	0.240	0.312
No. 12	186.6	41.4	4.7	0.029	0.016	0.006	0.690	0.178	0.323
No. 13	32.6	20.9	8.1	0.008	0.007	0.003	0.167	0.544	0.033
No. 14	61.9	45.5	8.6	0.019	0.042	0.010	0.377	0.399	0.094
No. 15	62.1	47.0	14.7	0.026	0.028	0.005	0.498	0.975	0.117
No. 16	21.7	10.7	7.4	0.010	0.004	0.017	0.512	0.261	0.157
No. 17	248.5	23.4	6.3	0.062	0.010	0.029	1.148	0.108	0.357
No. 18	154.4	21.4	3.6	0.058	0.025	0.004	0.829	0.547	0.245
No. 19	27.8	38.3	2.4	0.006	0.012	0.003	0.251	0.304	0.070
No. 20	102.2	13.1	6.4	0.019	0.006	0.003	0.359	0.069	0.188
Average	94.3	25.0	7.8	0.024	0.014	0.011	0.593	0.290	0.151

Envioronmental standerd (River)	SS
C type	25
D type	50
E type	100

	Pb
Envioronmental standerd	0.01
Effulent standerd	0.1

	Zn
Envioronmental standerd	0.03
Effulent standerd	5

S S
- under 25
- 25～50
- 50～100
- 100 over

P b
- under 0.01
- 0.01～0.1
- 0.1 over

Z n
- under 0.03
- 0.03～0.3
- 0.3～5
- 5 over

2. Year-round Investigation of No.3 and No.17

Table 2 shows result of Year-round Investigation of No.3 and No.17

＜Road runoff＞

Zinc concentration is 1.645mg/l on the average at No.3, 0.327mg/l at No.17. They largely exceed 0.03mg/l of environmental standards. All samples are over 0.03mg/l, and six percents of them are over 2mg/l of drainage standards, which are all at No.3.

Dissolved zinc concentration is 0.556mg/l on the average at No.3, 0.065mg/l at No.17. Share of dissolved zinc in zinc is 34% at No.3, 20% at No.17.

＜Roof runoff＞

Average zinc concentration is 0.059mg/l at No.3, 0.348mg/l at No.17. Average dissolved zinc concentration is 0.037mg/l at No.3, 0.296mg/l at No.17.

＜Rainfall＞

Average zinc concentration is 0.042mg/l at No.3, 0.583mg/l at No.17. Average dissolved zinc concentration is 0.037mg/l at No.3, 0.565mg/l at No.17. Value of No.17 is one digit higher than that of No.3.

Table.2 Year-round Investigation

		SS (mg/L)			Pb (mg/L)			Zn (mg/L)			D-Zn (mg/L)		
		road	roof	rain	road	roof	rain	road	roof	rain	road	roof	rain
Hashimoto five roads junction route 16	min.	4.9	1.5	1.0	0.001	0.001	0.001	0.500	0.018	0.010	0.285	0.016	0.009
	avg.	101.7	19.9	6.0	0.023	0.008	0.003	1.645	0.059	0.042	0.556	0.037	0.037
	max.	508.5	61.9	32.9	0.146	0.025	0.008	7.356	0.120	0.098	1.050	0.082	0.079
Left side of Komatsugawa bridge route 14	min.	16.4	3.1	1.0	0.007	0.002	0.002	0.099	0.152	0.161	0.036	0.084	0.066
	avg.	78.2	13.1	3.4	0.025	0.007	0.011	0.327	0.331	0.606	0.063	0.272	0.583
	max.	217.9	42.2	11.9	0.057	0.017	0.028	0.810	0.616	1.300	0.099	0.521	1.300

3. Investigation of detailed rain cases of No.3

Figure 3 shows time series variation of SS, zinc and lead at No.3. As lead and zinc have low correlation with amount of discharge (rainfall), lead and zinc might possibly flow out along with emission of SS (Suspended Solid).

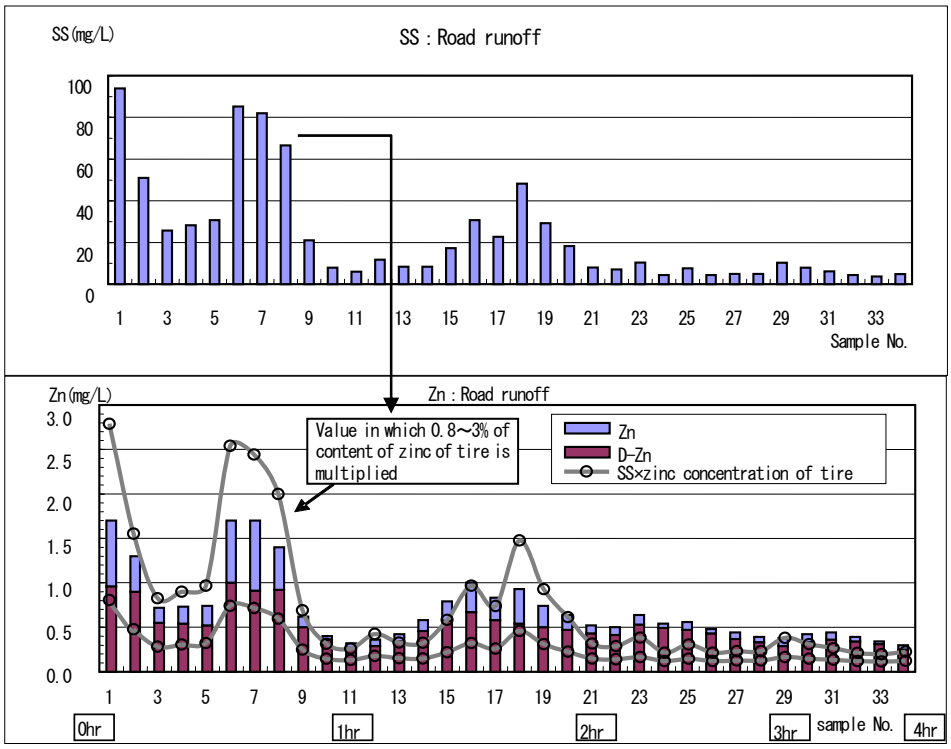

Figure.3 Results of detailed rain case

4. Ingredients analysis of road facilities (exposure test)

Road facilities which might contain zinc and lead, such as road sign pole etc., are examined ingredients analysis (exposure test) using same type of facilities. Results of exposure test shows that drainpipe contains Pb and all facilities contain Zn. Comparing pH3.5 case and pH7.0 case, pH3.5 case is higher in Zn concentration, and D-Zn of road runoff is influenced by elution from road facilities by acid rain. Zn is lower than actual survey result at No.3.

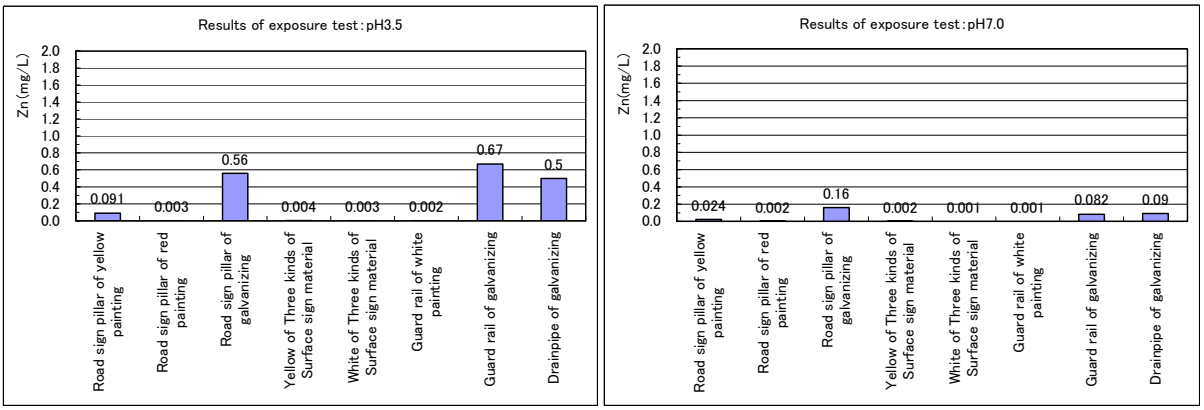

Figure.4 Results of exposure test

5. Source of lead and zinc included in road runoff

It seems that Suspended Solid runoff drives lead and zinc runoff.No.3 has highest zinc concentration in twenty observation points. Surveying road conditions of the spot, it is downward slope with a signal ahead and is located as braking span. So there are many barking marks. Zinc content of car tires are 0.8~3%, lead is 0.0001~0.0005% according to past hearing studies. Product of observed SS and zinc content rate of tires almost corresponds with observed zinc concentration.

It concludes that car tires may supply zinc. Because lead content of tires is about 1/1000 of zinc, it does not conclude tires is source of lead. Metal materials except tires may supply lead with Suspended Solid. Correlation between Pb and SS is 0.94, higher than that between Zn and SS.

6. Examination by isotope analysis

We analyzed the isotope of three kinds of zinc plats, and examined the emission source of zinc along with the analysis result of the tire and the road dust. As for the ratio of the isotope, of the zinc plating and the road sample, a different tendency was seen though the ratio of the isotope of the tire and the road sample was similar. It was guessed that the main emission source of zinc in road runoff was a tire.

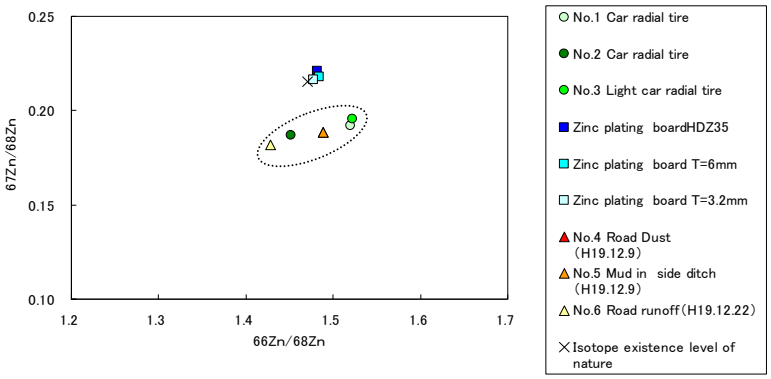

Figure.5 Relation between $^{67}Zn/^{68}Zn$ and $^{66}Zn/^{68}Zn$

7. Measurement survey concerning effect of road cleaning

In the investigation, we aimed to understand the influence that the road cleaning gave to the water quality of road runoff. We analyzed the water quality of road runoff by the rainmaking before and after the road cleaning, and examined the effect of the reduction of the negative environmental impact of the road cleaning.

We investigated by setting up the watering device road side belt based on the road condition in the investigation spot. SS in road runoff decreases greatly by the road cleaning as a result of the investigation, and Zn has decreased greatly along with it, too. The effect of the load reduction on the environment by the road cleaning was able to be confirmed.

・SS in road runoff greatly decreased from 142mg/l to 4mg/l after the road cleaning.

・Zn in road runoff greatly decreased from 0.307mg/l to 0.032mg/l after the road cleaning.

Photo.1 Road runoff before and after cleaning

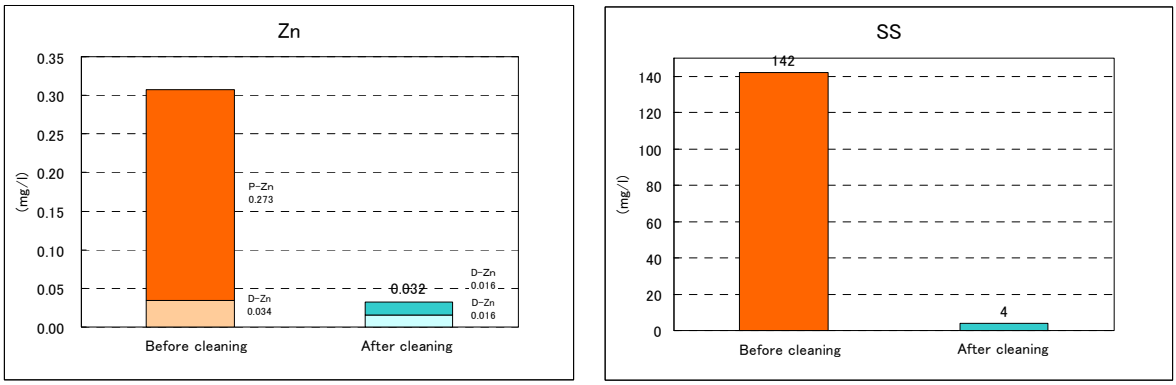

Figure.6 Concentration of road runoff before and after road cleaning (SS,Zn,Pb)